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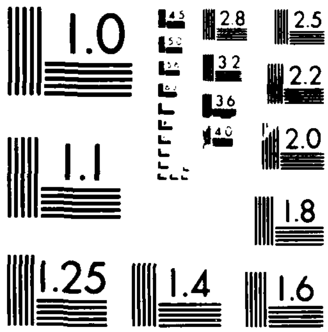

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RESEARCH MEMORANDUM

SUMMARY REPORT: MANNING THE 600-SHIP NAVY

Alan J. Marcus

A Division of CNA Hudson Institute

CENTER·FOR·NAVAL·ANALYSES

4401 Ford Avenue • Post Office Box 16268 • Alexandria, Virginia 22302-0268 • (703) 824-2000

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This study summarizes a series of projects designed to improve the Navy's ability to set manpower requirements and to develop cost-effective compensation policies to fill these requirements. The analyses included several efforts to improve the methodology used to define manpower requirements. A computer model was designed to help in the analysis of the impact of changes in the size of the fleet on requirements at the individual billet level. Development of methodologies to assess the potential for civilian substitution and to define test score and educational requirements for accessions was also completed. The impact of personal characteristics and Navy training on the performance of enlisted personnel was the subject of two separate research efforts. Finally, the effects of compensation policy on high-quality personnel and of sea pay on hard-to-fill sea-intensive billets were the subjects of two studies of retention behavior.

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ROBERT F. LOCKMAN
Director
Manpower Program

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ABSTRACT

This study summarizes a series of projects designed to improve the Navy's ability to set manpower requirements and to develop cost-effective compensation policies to fill these requirements. The analyses included several efforts to improve the methodology used to define manpower requirements. A computer model was designed to help in the analysis of the impact of changes in the size of the fleet on requirements at the individual billet level. Development of methodologies to assess the potential for civilian substitution and to define test score and educational requirements for accessions was also completed. The impact of personal characteristics and Navy training on the performance of enlisted personnel was the subject of two separate research efforts. Finally, the effects of compensation policy on high-quality personnel and of sea pay on hard-to-fill sea-intensive billets were the subjects of two studies of retention behavior.

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BACKGROUND

The Navy has undergone substantial growth during the first half of the 1980s; this growth trend will continue during the remainder of the decade. Enlisted manpower is expected to grow by 8 percent, from 490,000 in fiscal year 1985 to 530,000 in 1990. This is a significant increase in force size, but it should be viewed in perspective. During the same years, the number of Navy deployable ships will grow from 542 to 600, an 11-percent increase.

The early 1980s were very good years for the Navy from a manpower standpoint. Recruiting goals were met in absolute numbers. Quality of recruits had greatly improved over that of the 1970s, according to measures of quality such as the fraction of recruits who had high school diplomas and the fraction who were from the upper mental groups. Retention rates for career personnel were also substantially above those experienced in the past. These trends allowed the Navy to reduce a longstanding shortage of petty officers while expanding the overall force size.

Although the manpower situation has been positive in the past several years, continuing pressures make it difficult to maintain this state in the long run. The Navy needs to man a growing fleet at a time when the youth population is steadily declining. As shown in figure 1, the number of 17- to 21-year-olds in the population will decline throughout the 1980s and into the middle of the 1990s. Earlier studies have indicated that the Navy can meet manpower requirements, even at the expected lower population levels, but meeting them will not be easy or inexpensive.

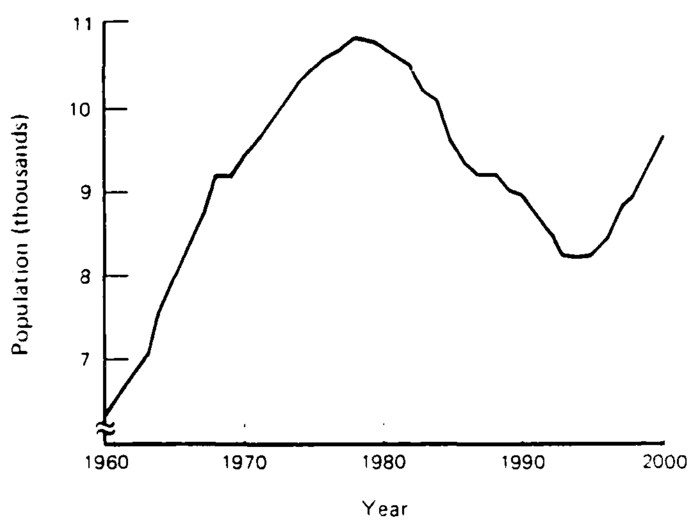

FIG. 1: POPULATION OF 17-TO-21-YEAR-OLD MALES, 1960-2000

The demographic trend is not the only factor that will make manning the 600-ship Navy difficult. In the early 1980s, unemployment was at its post-war high. This factor contributed to the high recruitment and retention levels. Unemployment has dropped from these record levels, but it is still well above traditional post-war levels. In all likelihood, unemployment will continue to decline in the second half of the decade, and this will make recruiting and retaining personnel more difficult. Improvements in the civilian economy are reflected not only in lower unemployment, but also by faster gains in earnings. After large military pay raises in 1980 and 1981, military pay has failed to increase at the same rate as civilian pay. Projections of the civilian-military pay ratio for the rest of the 1980s suggest that military pay will continue to slip relative to civilian earnings.

Demographic and economic trends will make the task of manning a growing fleet challenging. The political environment will also add to the pressure on the Navy. Large budget deficits have led to calls for cuts in many federal programs, and defense is no exception. Congressional caps on end strength have limited the growth in personnel to less than the growth that requirements dictate. Even if personnel and compensation policies keep pace with changes in demographic and economic conditions, the Navy may be forced to man the fleet at a lower level than planned.

In this environment, the Navy needs to define its requirements carefully and develop efficient and effective personnel and compensation policies to meet them. This study supports the Navy in achieving these goals by researching three general subject areas. The first involves improvements in the projection of enlistee requirements at the rating and pay-grade level. The second includes a series of analyses of the relationship between manning levels and quality and fleet readiness. The third investigates the value of several alternative personnel retention policies including both monetary and nonmonetary incentives. The first two analyses address the potential for personnel substitutions based on both cost and productivity to maintain readiness in the face of expected constraints on manpower levels. The third report summarizes the results of specific tasks in each of these areas.

DETERMINATION OF MANPOWER REQUIREMENTS

This section examines the way in which the Navy determines manpower requirements. It describes a model that could be used to project billets at shore installations in addition to those on ships and aircraft. It presents a method for determining which jobs are appropriate for civilian substitution and discusses the impact of this plan on military end strength. Finally, it describes the measures of recruit quality used in projecting manpower requirements.

PROJECTION OF REQUIREMENTS[1]

The Navy mans its billets through a complex and detailed centralized personnel system. Every job in the Navy is characterized by both a rating and a pay-grade requirement. Operational billets for ships and aircraft squadrons are defined in their Ship Manning Document (SMD) or Squadron Manning Document (SQMD), respectively. The Navy uses these documents in a model to project manpower needs. This model is essentially an aid in performing the calculations to determine the aggregate manpower requirements that result from various force mixes. Planners can determine total requirements for operational billets at the rating and pay-grade level by simply adding up the individual unit requirements. Changes in total operational requirements can be derived in a straightforward manner from these manning documents as the Navy grows and as differing mixes of ships and aircraft are introduced.

These billets compose only a portion of total Navy requirements, however. The Navy needs to fill a large number of jobs ashore. Despite progress in developing a system to define billet requirements at shore installations with a methodology similar to the SMD and SQMD systems, the Navy cannot determine shore requirements in a consistent framework. Planners cannot make accurate projections of shore requirements as a function of fleet size and composition. A model that could be used for this type of projection would allow manpower planners to explore the manpower implications of various future force mix decisions.

The determination of total shore requirements involves two steps. The first, and most problematic, is estimating the relationship between the sizes and types of units in the fleet and requirements for a shore establishment to support the fleet. Based on these estimates, Navy planners can determine total shore requirements and add them to operational billets requirements to project total manpower requirements.

Study-team members explored the feasibility of developing such a computer model to project future manpower requirements at the rating and pay-grade level for various force configurations. The project used the Enlisted Requirements Planner (ENREP) Model developed at CNA [2] as a starting point. The goal was to develop a prototype version of ENREP to test its usefulness as a planning tool and to use as the basis for an operational version if it proved successful.

The analysis conducted during the project provided updated billet requirements for ship and squadron manning and attempted to estimate the shore establishments associated with specific ship types. The research on shore requirements was based on historical relationships between ships in the inventory and associated shore billets. These relationships can be used to determine "planning factors" or mathematical algo-

1. This section summarizes analyses described more completely in [1].

rithms that translate changes in the number and types of ships in the Navy inventory into changes in shore requirements.

The estimates are preliminary. They are designed to test the feasibility of producing such factors rather than to provide a complete catalog of planning factors to be used in a working version of ENREP. The study team derived estimates for ships but not for aircraft squadrons. The results indicate that planning factors can be developed based on historical relationships but that a major effort would be required to estimate all the relationships needed to fully implement the model. Furthermore, strong statistical relationships cannot be found in all instances, and factors based on professional judgment as well as statistical analyses will be required.

Table 1 provides an example of data used to develop algorithms during the analysis. The study team estimated manning factors for a Ship Intermediate Maintenance Activity (SIMA) by comparing historical manning at East Coast SIMAs to the number and size of ships homeported there. Table 1 uses the basic allowance (BA) for the Electronics Technician (ET) rating.

TABLE 1

ET BILLETS BY PORT

SIMA	Charleston	Mayport	L. Creek
BA for ET rating at SIMA	53	42	27
Avg. size homeported ship	349	310	174
No. of homeported ships	38	35	23
Ratio of ET billets to ship BA	.00400[a]	.00387	.00674

SOURCE: U.S. Navy, Enlisted Billet File for FY 1984.

a. (53 ÷ (349 x 38)).

Although this work did not develop a complete and operational version of a requirements planner model, it made a large step in that direction. The software necessary to implement the model was written and tested. The key to the usefulness of the model, however, is the accuracy of the shore requirement estimates. Planners must establish additional manning factors for aviation units and validate all the estimates. Costs may be high, however, because these steps require a heavy initial investment and the model should be updated frequently to make ENREP a usable planning tool.

CIVILIAN SUBSTITUTION[1]

Projecting total requirements at the billet level is an important step in determining Navy requirements, but it is not the only issue that faces manpower planners. Some billets that are called for in the total requirements can be filled by either military or civilian personnel. Significant pressure is on the Navy to hold down military end strength despite the growth in the size of the fleet. One solution to this dilemma is the substitution of civilian for military personnel in shore billets. It may be possible to develop a methodology for the selection of those billets that are most amenable to civilian substitution. Research to develop such a methodology was conducted in this study.

The starting point for this research was the realization that Navy ratings vary greatly in factors such as training costs, retention costs, and amount of time required at sea. Therefore, a civilian substitution plan that was applied evenly across all ratings would probably not be cost-effective. This research attempted to create a process to identify those ratings that are the best candidates for civilian substitution and those that are the worst.

Navy ratings were evaluated on seven factors, although the time spent at sea and the costs of training and retaining personnel largely determined their scores. The evaluation used factor analysis and linear regression to rank the 71 ratings studied. The rankings are displayed in figure 2. They appear reasonable in that ratings clustered at the top of the scale tend to be those identified as mission critical by the Navy.

These results are intended to be used only as a general guide to potential civilian substitutions. Many factors influence the ability of the Navy to substitute civilian for uniformed personnel without reducing mission readiness. The study provides an example of the potential savings in military end strength, using some simple assumptions about where this substitution could take place.

Substitution of civilian for military personnel in shore jobs was assumed to take place in those ratings with low sea-shore rotation. This substitution would raise the sea-shore rotation of personnel in these jobs, and this was used as the criterion that determined the extent of substitution. Civilians replaced military personnel in an attempt to move the sea-shore rotation towards 6:3, which is comparable to that experienced in sea-intensive ratings. To limit the potential disruptions to the personnel system, the methodology allowed a maximum increase of 5 percent in any rating's sea-shore rotation. At the same time, it was assumed that military shore billets were added to sea-intensive ratings to bring the rotation pattern down toward 6:3. Many

1. The research described in this section is documented in [3].

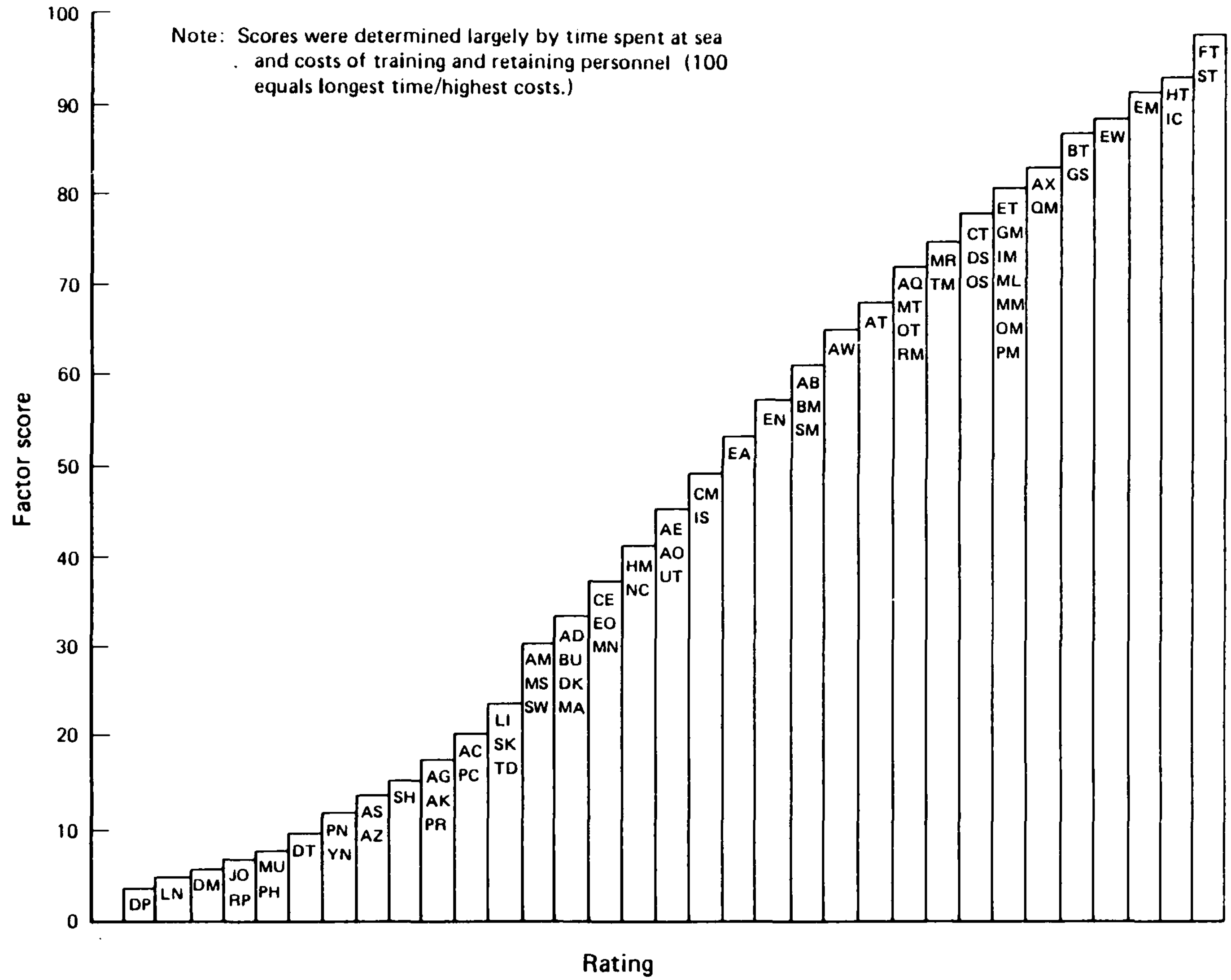

FIG. 2: NAVY RATINGS BY FACTOR SCORES

of the jobs that are subject to the reduction in uniformed shore billets have large populations of women, and this type of substitution could seriously affect their promotion patterns. In the analysis, sufficient billets were retained in these ratings to allow for career progression for women.

The potential for civilian substitution based on this methodology was calculated for each rating. The possible decrease in shore billets for uniformed personnel was 19,000, despite the increase required in some of the sea-intensive ratings. As noted before, numerous factors must be considered in setting requirements; therefore, this figure should not be thought of as anything more than one hypothetical result based on numerous ad hoc assumptions. Nonetheless, the method can be used to highlight ratings that are potential candidates for civilian substitution. It also allows for estimates of the potential magnitude of end-strength savings.

RECRUIT QUALITY[1]

Navy manpower requirements are stated in terms of the number of personnel in each rating and pay grade. This is sufficient for planning the career force, but not for recruiting new entrants into the Navy. Recruiting requirements are defined by quality as well as quantity. The Navy employs two basic measures of recruit quality. The first is educational achievement, defined as the successful completion of the requirements for a high school diploma. Education has been found to be the primary determinant of precontract attrition. High school diploma graduates (HSDGs) are preferred by the Navy because they are substantially more likely to complete their first term.

The second quality measure is a recruit's score on the Armed Services Vocational Aptitude Battery (ASVAB) and a summary ability measure based on these results, the Armed Forces Qualification Test (AFQT). The ASVAB is used to assign recruits to the ratings that they are qualified to learn and perform. The prerequisites for each rating can be translated into an upper mental group (UMG) goal, the desired proportion of recruits in the upper half of the AFQT distribution. This goal is used to target recruiting efforts by individual Navy recruiters and to monitor recruit quality for Congressional oversight.

Study-team members analyzed the process by which this goal is set for new male accessions. The goal is determined by the need to fill A-school seats for each rating with qualified recruits. The qualification requirements are stated in terms of various ASVAB components; therefore, a method to project the proportion of UMG personnel must be developed, based on the ASVAB requirements for each rating. Potential algorithms for the translation of ASVAB composites to AFQT requirements

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1. This work is described in detail in [4].

were tested; all had similar results. The study team made adjustments to the UMG requirements for each school to allow for attrition, fleet input, and number of women and used these to develop a final UMG goal for every rating. The team developed a computer spreadsheet model to aggregate the rating-specific requirements to develop a Navy UMG goal for any set of projected school loadings and assumptions about attrition and other inputs.

EFFECTS OF MANNING POLICY ON FLEET READINESS

The first section of the study involved research on ways to refine the process of determining manpower requirements. The underlying assumption is that the requirements are correct and can be viewed as absolute goals. In the real world, however, the actual manpower available to the Navy is consistently less than the stated requirements. Although overall readiness will decline if fewer personnel are available to the Navy, the degree to which shortfalls degrade readiness is not known. Personnel productivity can be expected to depend on factors such as experience and training. Substitution of personnel based on these factors may be used to respond to shortfalls or to adjust requirements to increase cost-effectiveness. More precise information on the productivity of personnel with different attributes is necessary before manpower planners can accurately alter fleet manning to improve readiness. This study included several efforts to measure personnel productivity as a first step in improving the manpower requirements process.

FLEET TRENDS

The material condition of ships is a potential indicator of fleet readiness. A simple examination of the trends in this measure and in manning levels shows that the two tend to move in the same direction. Figure 3 presents the fleetwide average of the proportion of time free of serious equipment failures and average fleet manning levels. A decomposition of manning levels into junior and senior billets indicates that senior personnel are more closely related to fleet material condition measures. The coincidence between these two time trends is not sufficient to establish a cause-and-effect relationship between them. In fact, attempts to quantify this relationship at the individual ship level have proved less successful [5]. Nonetheless, the apparent relationship between manning and fleet readiness is worth pursuing further.

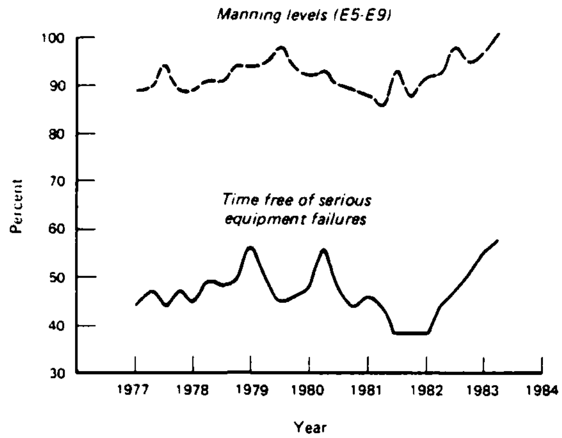

FIG. 3: READINESS TRENDS

FIRST-TERM PRODUCTIVITY GROWTH[1]

One of the basic manpower issues facing the Navy is selection of the proportion of first-term and career personnel in the force. A key factor in determining the appropriate mix of these two types is the relative contribution of each to Navy readiness. The study analyzed the growth of productivity within the first term of service and used this measure to compare the relative contribution of first-termers to enlistees beginning their second term.

Another important question is the impact of personal characteristics, such as education or mental group, on performance. Objective measures of on-the-job performance are difficult to obtain. The study used a unique data set to address the question. The analysis concentrates on the first term in the Navy and examines the patterns of productivity growth for individuals in different ratings and with varying characteristics.

Data

In 1974, the Rand Corporation conducted a survey project for the Defense Advanced Research Projects Agency. The project, which involved two surveys, was intended to measure the growth of net productivity over the first enlistment term.

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1. The analysis summarized below is based on research documented in [6].

Researchers chose a set of military occupations to represent the full spectrum of skills required by the services. They selected a total of 19,000 first-term enlistees from the chosen skill areas in the Air Force, Army, and Navy and sent each enlistee a questionnaire form requesting background information not included in their personnel files and the names of three immediate supervisors. A total of 6,558 Navy enlistees (72.9 percent) responded to the questionnaire. The supervisors identified in these responses were sent a second questionnaire to ascertain the net productivity of the individuals in the first wave.

The questionnaire asked supervisors to assess each recruit's net productivity as of the survey date and to assess the recruit's prospective net productivity 1 year later and after 4 years at the duty station. The questionnaire also asked them to assess the recruit's net productivity after 1 month at the duty station. All net productivity estimates were relative: the net productivity of the trainee at time t relative to the net productivity of the average specialist within the occupation after 4 years at the duty station. Although the survey included only 15 of the approximately 100 Navy ratings, the ratings chosen account for about one-third of all Navy enlistees.

Typical Learning Curves

Each supervisor was asked to rate a "typical" recruit's net productivity at several points in his first term. Estimates of the progress of a typical recruit can be used directly to identify differences across ratings in the shape of the learning curve. Table 2 presents the mean values of the supervisory assessments of the net value of a typical A-school-trained recruit at several points in his first term. The net value is expressed as a percentage of the productivity of an average specialist in that rating after 4 years at the duty station. The patterns across ratings are similar, although not identical.

TABLE 2

COMPARISON OF PRODUCTIVITY

Rating	Relative productivity[a] Index 1	Index 2
ET	41.46	51.71
AE	45.69	52.66
MM	47.79	52.29
EM	49.79	55.60
RM	51.91	56.54
MS	55.94	58.41
AD	55.51	60.20
EM 3354	37.79	51.41
ET 3353	29.60	48.20
MM 3355	32.03	43.41

a. Expressed as a percentage of the productivity of trained specialists in the rating.

The average productivity values provide information about the growth of productivity in the first term and on the relative value of a first-term recruit compared to a careerist (an individual with 4 years of experience). It is difficult to use these numbers directly in applied analyses, however, so indexes of the relative value of a first-term recruit to a careerist were developed.

The study constructed two alternative indexes to measure the productivity of first-term personnel relative to that of trained specialists. The definition of a trained specialist, an individual with 4 years of work experience in his specialty, came from the survey questionnaire. By definition, the output of a trained specialist equals 100.

The first index is the average output of first-term recruits during their first 4 years in the Navy, expressed as a percentage of the output of a trained specialist. Graphically depicted in figure 4, this index equals the shaded area minus the area where net productivity is negative or, more formally:

$$I1 = [\int_{t_0}^{48} P(t)dt]/48,$$

where,

t_0 = month of arrival at first duty station

$P(t)$ = net productivity at time t, as a percentage of the output of a 4-year specialist.

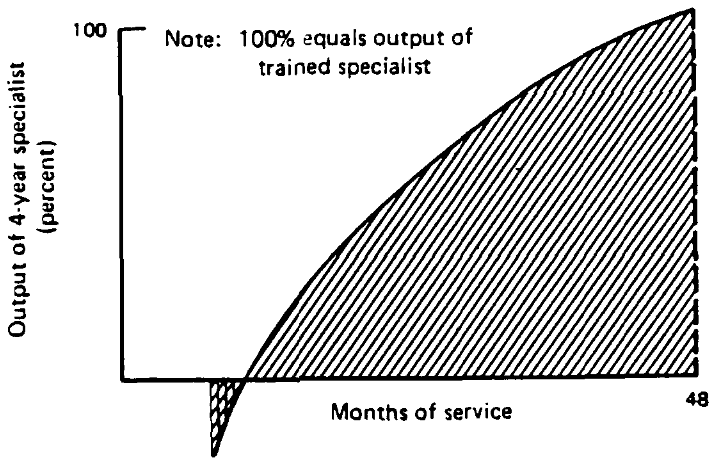

FIG. 4: HYPOTHETICAL MEASUREMENT OF PRODUCTIVITY OF FIRST-TERM RECRUITS

This index allows cross-rating comparisons of the relative productivity of first-termers during the first 4 years of service. Productivity during formal training is assumed to equal zero and therefore does not appear in the integral, although it does enter the denominator.

The second index looks at the relative productivity for 4 years after arrival at the first duty station. Since individuals in different ratings spend different amounts of time in training before arriving at the first duty station, this index is not quite as convenient for comparisons across ratings. Since the second index measures productivity over a longer period of time, thus capturing more productive time relative to that spent in training, it is always larger than the first index. Table 2 shows that, except for the nuclear-related ratings (for which training time is very long), both indexes order the ratings in similar fashion.

These indexes show a pattern. The ordering of relative productivity is essentially inversely related to the ordering of skill levels in the ratings. The most technical ratings display the smallest first-term productivity. This effect is strongest for the first index, reflecting in part the length of A-school training. The same effect is evident--though less dramatic--in the second index, in which the impact of training time is removed because the output measurement begins only after formal training is completed.

Mental Ability, Education, and Job Performance

In the previous sections, the supervisors' responses about the typical path of productivity were used to determine the effect of Navy experience on relative productivity. A more difficult question is the impact of personal characteristics, such as education and AFQT scores, on productivity. The question is important to the Navy because individuals from the upper mental groups and those with more education are more expensive to recruit and retain.

To estimate the effect of mental ability and education on productivity, researchers must examine the supervisor's evaluation of the relative productivity of each recruit at four points: on the survey date, 1 year later, and at the beginning and end of the first term. Regressions can be estimated, controlling for supervisors' differences, to analyze the growth of productivity within the first term. These regressions are estimated separately for personnel in each of the ratings.

This is a straightforward task that yields reasonable results. The shape of the learning curve derived from these regressions is similar, although not identical, to those obtained in the earlier analysis of "typical" recruits, but the effects of mental ability and education are inconsistent across ratings.

Before summarizing these results, some econometric problems inherent in estimating productivity within specific ratings must be addressed. The next section describes a model that deals with these problems.

RATING ASSIGNMENT

The Navy has approximately 100 ratings that vary substantially in entry and training requirements. Recruits can frequently select the rating for which they want to train, but this choice is subject to availability of school seats and to rating-specific qualifications. Many recruits enter the Navy without a school guarantee or with a general guarantee that does not specify the school. A few others are designated in a rating through on-the-job training (OJT) without attending an A-school.

At both the recruitment and classification stages, the Navy attempts to steer recruits into ratings that are undermanned and in which the recruits are likely to be most productive. For example, recruits in the upper mental groups are consistently encouraged to enter the most technical ratings. As a result of both individual choice and Navy needs, then, the assignment of recruits to ratings is nonrandom. The factors that determine rating assignments are related to the factors that determine productivity within a rating; they may in fact be the same factors. This phenomenon creates significant statistical problems. If the most able recruits enter the most technical ratings, estimates of the effect of such factors as education and AFQT score on productivity could be biased downward.[1]

The ratings used here are more concentrated in the technical range than the overall Navy distribution. Table 3 displays the skill categories of these Navy ratings. The selection problem discussed earlier is most severe for category 2. In this group, two thresholds are operating: Some recruits are not assigned to a rating because they are underqualified for it; others, because they are overqualified.

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1. A more detailed description of this problem is included in appendix A of [6]. It should be noted that to be in the sample, a recruit must successfully complete formal training and not leave the Navy. This additional selection process is implicitly modeled in this research, as well.

TABLE 3

SKILL CATEGORIES OF RATINGS

Category 1 (medium skilled)	Category 2 (highly skilled)	Category 3 (nuclear qualified, highly skilled)
AD	EM	EM 3354
AE	ET	ET 3353
MS	MM	MM 3355
RM		

NOTE: Distribution of recruits in these categories is as follows: 25 percent in category 1, 52 percent in category 2, and 23 percent in category 3.

Regression Results

Based on these ordered-probit estimates, the study team created a correction factor for the probability of assignment to ratings for each individual.[1] The team included this factor with the other regressors and estimated regressions of productivity on individuals' characteristics and Navy experience.

The learning curves are shaped by the coefficients on time-at-the-job. The derivatives of the learning curves at several points in time are shown in table 4. The patterns across the ratings are very similar. In general, productivity grows at about 3 percent per month in the middle of the first term. The curves are slightly steeper and do not flatten quite as quickly for most technical ratings, but the differences are small. Time-in-service prior to arrival at the duty station seems to have an effect on productivity for the more technically demanding skills. The effect, however, is much smaller than the effect of time-at-the-duty-station.

The estimation of the effect of time-on-the-job on productivity does not depend on the specification of the model. The estimated coefficients remain the same between the ordinary least square (OLS) and selection-corrected equations.

The effect of time-on-the-job on productivity could have been obtained much more simply by examining supervisors' attitudes about the typical trainee. To analyze the effect of mental ability and education

1. Reference 6 includes a definition of this correction factor.

on productivity, however, regression estimates are necessary. Here, the impact of modeling the assignment process becomes apparent.

TABLE 4

MEASURE OF PRODUCTIVITY GROWTH

Rating	MTJ (TJ = 12)[a]	MTJ (TJ = 24)[a]	MTJ (TJ = 36)[a]
AD	3.23	1.96	.68
AE	3.38	2.01	.65
MS	2.15	1.40	.66
RM	3.35	1.91	.47
EM	3.15	1.95	.75
ET	3.43	2.04	.64
MM	2.91	1.83	.75
EM 3354	3.34	2.09	.85
ET 3353	3.69	2.34	1.00
MM 3355	3.46	2.19	.91

a. TJ = time-on-the-job, expressed in months.

In skill category 2, the assignment procedure would be expected to have the largest effect on productivity. The recruits who are qualified for and assigned to these ratings are among the best available to the Navy, although the very best are encouraged to enter the ratings in skill category 3, which requires additional training in nuclear power.

Table 5 shows those results that pertain to the effects of education and AFQT score on productivity. The use of the model that accounts for the assignment procedure shows a dramatic effect of individual characteristics on performance. This is particularly true for the AFQT coefficients.

TABLE 5

PERSONNEL QUALITY REGRESSION COEFFICIENTS

EM rating

Characteristic	OLS	Corrected
AFQT	-.03	.10
	(.6)	(2.6)
HSDG	6.2	6.5
	(4.1)	(4.1)

ET rating

Characteristic	OLS	Corrected
AFQT	.05	.58
	(.8)	(2.4)
HSDG	6.3	8.0
	(3.0)	(3.7)

MM rating

Characteristic	OLS	Corrected
AFQT	.13	.34
	(2.8)	(2.0)
HSDG	6.2	7.3
	(3.6)	(3.8)

NOTE: Numbers in parentheses are t-statistics.

In the OLS equations, the coefficients on AFQT are small and insignificant for two of the three ratings. When the selection-corrected equation is estimated, the coefficients increase substantially and, with one exception, are all statistically significant. The coefficients for the ET rating, for example, imply that a 10-point increase in AFQT (approximately one standard deviation) leads to an

increase in productivity of 6 on the 100-point scale. This number implies a 12-percent increase in the value of the indexes calculated in table 2. The corresponding increase for the MM rating is roughly 7 percent. The two estimates for the EM rating are so divergent that no exact calculations are reported, but the pattern of results again indicates that the selection-corrected model shows a larger effect than the simple OLS version.

A comparison of the OLS and corrected models tells a similar, though less consistent, story for the impact of education. Acquisition of a high school diploma implies an increase in productivity of more than 10 percent for each rating when the selection-corrected model is estimated.

In the past, difficulties have been encountered in estimating the impact of mental ability and education, which are assumed to be proxies for quality, on productivity. The results presented here imply that one of the reasons for this problem is failure to account for the occupational-assignment process. When occupational assignment is considered, the findings indicate that mental ability and education have a substantial effect on productivity.

Upper and Lower Categories

Researchers expected the problem of rating-assignment bias to be the most serious for skill category 2. Although the results for this group show significant improvement when the selection process is corrected for, this is not the case for the other ratings. For categories 1 and 3, the joint model leads to results that are much less precise than the OLS estimates. The coefficients on education and AFQT score are consistently less precise, and their signs are contrary to expectations.

These findings are not easy to explain. The ordered-probit model does not fit the data as well at either tail of the distribution. By its nature, the selection-corrected model suffers from multicollinearity and may simply not be robust when the fit on the assignment equation is not precise.

The OLS coefficients on the AFQT variable for skill categories 1 and 3 are basically comparable to the OLS estimates for category 2. Some researchers may infer that the true effects are comparable to those found for the ratings in category 2 and that the estimating techniques used are simply not robust enough to measure them precisely. However, this inference is probably a case of grasping at straws. Nonetheless, the OLS estimates are likely to be lower-bound estimates, which suggests that AFQT scores do significantly affect performance.

The corresponding results on the education variables, however, show no pattern at all. The interpretation of these coefficients is left as a topic for future research.

OPERATIONAL READINESS AND TRAINING[1]

The final task to be discussed in this section concentrated on three areas that have been infrequently researched. First, the study analyzed operational data that are realistic measures of wartime capability. Second, in addition to estimating the effect of factors such as military experience and personnel characteristics on performance, the study examined the effect of mid-career training on the performance of personnel--particularly the impact that training in flight simulators has on crew performance. Finally, this study looked at the reserve component of the force, a segment of the military that has not received intense interest in the past. The reserves serve only a limited time each year; therefore, significant questions have been asked about their readiness and what policies can limit skill loss as time away from active duty increases.

Data

Simulator exercise results were gathered for a sample of nine Naval Selected Reserve P-3 squadrons from 1980 through 1982. The P-3 is a long-range patrol aircraft whose primary mission is antisubmarine warfare. Crewmembers on ASW aircraft, both officers and enlistees, spend a substantial amount of time in simulators. These sessions, which often last several hours, are used both as training exercises and as indicators of crew readiness. The individual crewmembers and the crew as a whole are graded on their performance, and results of these exercises are recorded. The sample includes 365 simulator trials and over 1,000 individual exercise grades.

In addition to simulator flights, actual operational flights are graded. Data on grades from these flights were collected. Unfortunately, these data are too limited to be useful in these analyses. Reserve units fly a small number of operational missions each year; therefore, the data set derived from operational records was too small to be used. This problem is exacerbated by the fact that these operational flights tend to be concentrated among a small number of crews within the squadron. As a result, only information from simulated flights are used in this study.

The study focused on the three enlisted sonar operators in the aircrew. Individual exercise grades were merged with personnel files that include extensive information on individual characteristics and on

1. The analysis discussed in the following section is presented more comprehensively in [7].

Navy training and experience. The information covers four areas: personal characteristics, flight characteristics, reserve training information, and simulator experience.

Model

Three factors fall in the category of personal characteristics: pay grade; experience in the Navy as well as advancement rate (in previous studies, the most powerful predictor of individual performance); and education level. Many reservists had completed additional years of schooling after leaving the Navy, so this variable does not measure education at the time they entered the service.

The score a crewmember receives on the flight evaluation depends not only on individual proficiency. It also depends partly on the characteristics of the job, such as the difficulty of tasks involved and the individual's position on the aircraft as Sensor 1, Sensor 2, or Sensor 3. Sensor 1 and Sensor 2 operate the acoustic detection devices. Sensor 1 is the lead operator, and Sensor 2 provides support. Sensor 3 operates the nonacoustic devices and has a limited role on many flights. The analysis takes account of the individual's position on each flight and the type of mission being simulated.

A key concern in any analysis of reserve readiness is a comparison of the performance of reservists to active-duty personnel. As previously noted, the study found insufficient data to compare reserve to active personnel. The reserve community, however, has two types of personnel: the Selected Reserves (SELRES), who make up about three-fourths of the reserves and serve one weekend a month and 2 weeks a year of active duty; and the Training and Administrative Reserves (TARs), who serve full-time but are attached to reserve units.

This study assumed that TARs are equivalent to active-duty personnel and that data on SELRES and TARs can be used to compare the performance of reserve personnel to active-duty enlistees. In addition to exploring the differences between these two types of reservists, the study examined the impact of training on the readiness of reserve personnel. Since the extent of skill loss of reservists and the impact of training on reducing skill loss is of great concern to the Navy, the study also examined the effect of time-since-active-duty on the performance of personnel. This may be affected by the amount of time the individual actually spent on active duty, which is considered as well. Finally, the study analyzed the impact of the reserves' 2 weeks of active-duty training by measuring the time since the last period of active-duty training for each individual.

Finally, the study assessed the importance of simulator training in improving performance. The effectiveness of personnel was measured as a function of the number of simulator trials performed during the study

period. A more extensive study might concentrate on the time between these trials as well as a simple count of their number.

Results

The study used regression analyses to estimate the factors that determine simulator scores. Simulator trials are scored on a 100-point scale. Numerous individual tasks with different weights are graded and added to determine an overall grade. Although the mean score is close to 90, there is still variation across the sample.

Researchers estimated equations relating simulator scores to characteristics. In general, all the results are in accord with their expected signs. The magnitude of many of the effects is much smaller than would have been expected, however. This is true, in particular, for individual characteristics. The variables measuring education have been deleted entirely from the regression equation. The coefficients, whether measured by years of education or degree status, are statistically insignificant and change sign depending on the specification of the equation. AFQT score has a positive but miniscule impact on simulator performance. Individuals in the higher pay grades performed better, but again, the differences were quite small. There is no clear reason why these factors have so little explanatory power. The most likely explanation has to do with the nature of the reservists in the study's sample. They have an average of 15 years of experience in active duty and reserve activity; therefore, they must be reasonably competent at their jobs. Because of this, one can expect that differences in individual characteristics will be less important than they might have been earlier.

The variables that are included to control for differences in flight tasks are all statistically significant. They are included to control for the possibility that individuals are sorted into flight positions or crews into particular flights based on their personal characteristics. These variables prevent spurious correlation between personal characteristics and simulator scores based on a nonrandom sorting of individuals based on the type of task performed.

The implications of these results for the readiness of reserve units are very interesting. The most important issue for reserves is whether or not reserve crewmembers can perform adequately. The answer obtained from this study is strongly affirmative. The results indicate that SELRES crewmembers are, in fact, slightly better than their TAR counterparts. Even though the difference is statistically significant, it is so small that SELRES and TARs can be considered equivalent. This result is important because SELRES are often assumed to be less effective than full-time enlistees.

These results do imply some degree of skill loss over time, as measured by the negative coefficient on years-since-leaving-active-duty.

Even though this variable is negative and statistically significant, its magnitude is quite small. For the average reservist, who has been off active duty for 11 years, the score is only about a point and a half lower than that of someone coming right from the active force. This suggests that the training of reservists, at least for patrol aircraft squadrons, is sufficient to maintain their competence.

Two variables are included to examine skill training more specifically. The first, time since the last period of active duty for training, has virtually no impact on the simulator score. This finding has two possible explanations. One is that training has little impact on performance for experienced personnel. A more likely explanation is that most reservists train on a regular basis; therefore, the time intervals between training sessions are too short to have a measurable impact.

The second variable identified individuals with missing training records. No record of the last training period was available for one-fifth of the crewmembers. This may be due to bad recordkeeping, but it may also indicate that no training has been conducted for a long period. The study found that individuals with missing training records had slightly lower scores.

Simulator Training

Flight simulators serve two functions. They can be used to measure the readiness of individual crewmembers, as in this analysis. They can also be used as training devices to improve the performance of these individuals. Their usefulness as training devices can be measured by examining the impact of a session in the flight simulator on subsequent simulated flights. Figure 5 displays the mean flight score of all individuals by the number of simulated flights during the observed period. It clearly shows a strong upward trend. The regression estimates predict an average increase of more than one point for each simulator flight, although this effect declines slightly with each subsequent flight.

Flight-simulator training leads to substantial improvements in subsequent simulated flights. Its effectiveness in improving performance during real flights remains untested. As noted before, the study found that too few observations had been made on reserve-unit operational flights to compare the relationship between performance in simulated and actual flights carefully. The flight simulators used in these tests are very realistic, however, and the units that use them place great confidence in them. This suggests that time in the simulator does produce improvements in the operational performance of VP crewmembers. The magnitude of this effect may not equal the estimates obtained here--in fact, it is probably smaller; still, evidence shows that simulators can be used effectively to provide training to these crewmembers.

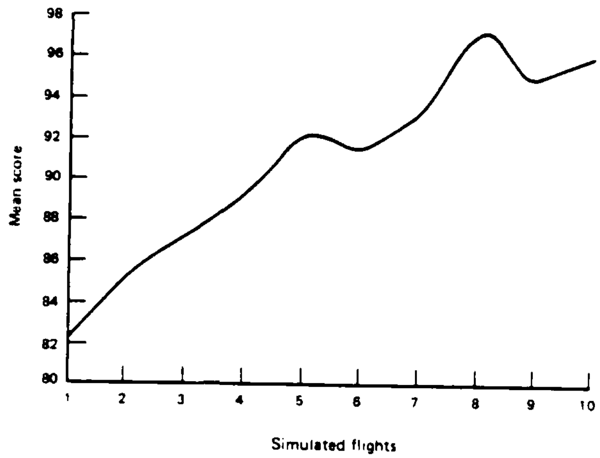

FIG. 5: SIMULATOR SCORES BY EXPERIENCE

This analysis emphasizes the impact of training on performance. The data come from Naval Reserve patrol squadrons. Training is particularly important for reserve units that do not serve on a regular basis. Although this analysis is an initial effort in this area, the results are encouraging. Enlisted reservists experience very little skill loss over time. The typical reservist, who has been out of active duty for more than 10 years, performs his job about as well as someone coming directly off active duty. The Selected Reserve enlistees score as well on simulated flights as their full-time counterparts. Both of these results suggest that reserve training accomplishes its purpose.

EFFECTS OF COMPENSATION POLICY ON RETENTION

The analyses summarized thus far have concentrated on the definition of requirements and the implications for readiness of failing to meet requirements or for filling requirements with different types of personnel. These analyses can help the Navy determine the number and type of personnel to recruit and retain. How best to keep the appropriate mix of personnel in the force is a subject of substantial research. This study addresses two specific compensation issues. The first is the impact of pay policy on the quality of those deciding to reenlist. The second is an assessment of the current state of the sea-pay program.

COMPENSATION AND QUALITY[1]

The Navy has made substantial progress in eliminating its long-standing shortage of petty officers but, as it grows toward the 600-ship force, it will have to retain increasing numbers of personnel to attain career-force objectives. Previous research has made it clear that personnel can be retained in sufficient numbers if pay and personnel policies are used appropriately.

Will the Navy, however, be able to maintain (or improve) its current level of personnel quality as it retains large numbers of careerists? This question has not been seriously explored. Growth in demand for personnel will be greatest in the most technical Navy jobs, which makes the issue of quality even more critical. Researchers examined this question and evaluated various policies for increasing retention and the quality of personnel retained. Analysis is limited to the first reenlistment decision; continuing research will include subsequent decisions.

The Navy policy that has the greatest impact on retention is the level of pay. The two major components of Navy pay are Regular Military Compensation (RMC) and Selective Reenlistment Bonuses (SRB). The Navy has numerous other special pays, such as sea pay and proficiency pay, but they constitute a small portion of total compensation and have not been considered in most of the work on compensation.

Many analysts have studied the effect of pay on first-term reenlistment rates. The impact of pay is normally measured as an elasticity which measures the percentage change in reenlistment resulting from a percentage change in pay. Estimates of the elasticity of reenlistment with respect to pay, with pay measured by RMC and SRB both separately and jointly for various years and data sets, have been remarkably consistent. A review of more than a dozen studies of first-term reenlistment [9] found that the distribution of results is centered just above 2.0 and that virtually all the estimated elasticities have been between 1.0 and 3.0. Most studies have assumed that all Navy personnel exhibit the same pay response. Two recent studies [10,11] allowed for varying response rates by estimating separate elasticities for different occupational groups. Both found some differences between occupational groups, but, in general, the estimates of pay responsiveness were quite close to those found in earlier work.

A major factor that influences retention is the state of the economy. Although the Navy has no control over this, it can plan future policy based on forecasts of economic trends. Levels of Navy pay can only be interpreted relative to civilian wages. When policymakers consider the impact of a 5-percent increase in Navy pay, they must

1. The research summarized here is contained in [8].

realize that the actual effect depends on the size of the change relative to increases in civilian wages. The other major indicator of economic conditions is the national unemployment rate. Reenlistment rates are sensitive to the unemployment rate, increasing when the unemployment rate increases. The effect of unemployment on retention has been found to be substantial even though it is less often analyzed than the effect of pay on retention. Estimates used by CBO [9] indicate an elasticity of .5 for first-term reenlistment. Although this elasticity is somewhat less than that corresponding to pay level, it is still significant. Translating this elasticity into actual changes in retention, a 1-percentage-point decrease in the national unemployment rate leads to a 3-percentage-point decrease in the reenlistment rate for first-term personnel. The unemployment rate is much more volatile than pay, so historically it has had a greater impact on retention.

Earlier analyses have also found that education and AFQT influence retention. Individuals with more education and higher AFQT tend to have lower reenlistment rates. In large part, this appears to be the result of their enhanced civilian opportunities. It should be noted that this result applies to people reaching the end of their first-term and does not take into account the lower pre-contract attrition of better recruits, high-school graduates in particular.

These findings are disturbing because evidence shows that education and mental ability both have significant impacts on job performance. Past analyses indicate that the Navy is most likely to lose its most productive personnel at the first reenlistment point. Consequently, researchers will examine the relationship between performance and retention and evaluate policies for encouraging higher retention among personnel who contribute the most to Navy readiness.

Personnel in the Rand Corporation survey [12] were matched to the annual Navy Enlisted Master Record (EMR) and followed until they either left the Navy or reenlisted. Table 6 displays the ratings and the number of personnel observed in each category along with the mean reenlistment rate for each rating. To create a fairly homogeneous data set, the study excluded personnel in the nuclear power program, who have 6-year initial obligations and consistently high bonuses. The MS rating showed substantial changes during the sample years, so it was also dropped from the data set. Preliminary analysis indicated that the AD rating was somewhat different from the others. It was excluded, although including it did not change any qualitative results. Table 7 displays the variables collected for each person and their mean values.

TABLE 6

RATINGS AVAILABLE FOR ANALYSIS

Nonnuclear ratings	N	Reenlistment rate
Aviation Machinist's Mate (AD)	41	.293
Aviation Electrician's Mate (AE)	19	.158
Electrician's Mate (EM)	392	.110
Electronics Technician (ET)	291	.089
Machinist's Mate (MM)	309	.152
Mess Management Specialist (MS)	197	.310
Radioman (RM)	219	.210
Nuclear ratings (NEC)		
EM (3354)	178	.157
ET (3353)	168	.083
MM (3355)	244	.131

TABLE 7

INDEPENDENT VARIABLES

Variable	Mean
HSDG (=1 if high school diploma graduate)	.87
GED (=1 if received GED)	.05
AGE (age at entry into Navy)	19.2
NW (=1 if race not white)	.05
AFQT (score)	72
PG3 (=1 if pay grade E-3)	.11
PG4	.53
PG5	.34
PG6	.02
MULT (SRB multiple at time of reelistment decision)	3.0
UER (Aggregate Unemployment Rate at time of reenlistment decision)	6.9
MIL2CIV (pay index at time of decision = RMC (E-4, LOS4, family size=3)/CPI	.55
EXTEND (=1 if extended prior to reenlistment decision)	.10
FY 74 (=1 if decision made in FY 74)	.002
FY 75	.08
FY 76	.12
FY 77	.42
FY 78	.06
FY 79	.06
FY 80	.02
PR4 (supervisor's assessment of productivity at LOS4 relative to a fully qualified specialist = 100)	89.6

In the data available, it is impossible to accurately determine whether an individual is ineligible to reenlist. This is not a serious problem since the number of ineligible individuals is quite small. During the period of time covered by the analysis, personnel who had not made E-4 were not normally eligible for reenlistment. To reduce the problem caused by the eligibility question, the analysis was limited to personnel in pay grade E-4 and above.

Because the period of time in the sample is quite short, the study found no substantial changes in the measure of RMC relative to civilian pay or in the unemployment rate, so it also employed a second specification with dummy variables for each of the sample years to account for changes in the national economy and Navy pay. Results from each of these specifications are presented in table 8, but the choice of models does not substantially change any results.

Retention Estimates

The study estimated the probability of reenlisting based on personal characteristics, pay grade, SRB level in the rating, unemployment rate, and an index of military pay. Results are presented in table 8. Directly interpreting the logit coefficients is difficult, so the table includes the partial derivatives of the reenlistment probability with respect to the independent variables evaluated at the mean reenlistment probability. For example, high school diploma graduates have a predicted reenlistment rate 6.2 percentage points lower than that of nongraduates. Very little difference is found between the model that uses annual dummy variables to describe time-series variation and the model that includes the unemployment rate and the pay index. To avoid redundant calculations, the following paragraphs discuss only the results from the model using pay and unemployment, although both sets of results are presented in table 8.

The effects of individual characteristics are reasonable and basically consistent with previous findings. High school graduates and GED recipients are less likely than nongraduates to reenlist. Nonwhites are more likely to remain in the Navy. Personnel who enlist in the Navy at a later age are also more likely to remain; this reinforces the earlier findings on the importance of entry age. The coefficient on AFQT is small and insignificant. Study-team members expected a negative AFQT coefficient, reflecting higher potential civilian earnings; this insignificant finding cannot be readily explained.

TABLE 8

ESTIMATES OF REENLISTMENT EQUATIONS

Variable[a]	Coeff	(t)	[Partial]	Coeff	(t)	[Partial]
Constant	-5.94	--	--	-20.61	--	—
HSDG	-.62	(2.0)	[-.07]	-.55	(1.8)	[-.06]
GED	-.37	(0.8)	[-.04]	-.34	(0.7)	[-.04]
AGE	.12	(2.1)	[.01]	.11	(2.0)	[.01]
NW	1.45	(4.2)	[.16]	1.44	(4.3)	[.16]
AFQT	.0025	(0.4)	[.0003]	.0012	(0.2)	[.0001]
PG5	.83	(4.4)	[.09]	.79	(4.2)	[.09]
PG6	1.28	(2.2)	[.14]	1.25	(2.3)	[.14]
MULT	.15	(1.2)	[.02]	.18	(1.6)	[.02]
UER	—	--	--	.36	(2.9)	[.04]
MIL2CIV	—	--	—	24.50	(2.4)	[2.7]
EXTEND	.98	(3.5)	[.11]	.92	(3.3)	[.10]
x^2	99.7	--	--	88.2	--	--
N	1103	--	--	1103	--	--
$(P\|\bar{x})$	.125	--	--	.13	--	--

a. Dummy variables representing Navy ratings and decision year are also included.

The effect of a one-level increase in the bonus multiple is to raise the reenlistment rate by 2 percentage points. Translating this into a pay elasticity yields an estimated elasticity of 2.1.[1] This result confirms the findings of numerous other studies. An alternative pay-elasticity estimate can be derived from the coefficient on the pay index. This elasticity estimate equals 9.5, which is unreasonably high. The unemployment elasticity equals 1.8, which is also substantially higher than that found in earlier work. These results are probably due to the very short time series available in the data and should be interpreted very cautiously.

The effect of pay grade on retention is dramatic. The reenlistment rate for an individual at pay grade E-5 is 9 percentage points (or more than 50 percent) higher than for an individual at pay grade E-4. Table 9 shows the pay levels associated with these pay grades, based on a length of service of 4 years (LOS4). An E-5 earns only 5 percent more

1. During the years observed SRB was paid in annual installations. A one-level increase in SRB can, therefore, be treated as an additional month of base pay, and the resulting change in pay is converted into a percentage pay increase.

than an E-4. If advancement affected retention only because of this pay increase, the implied pay elasticity would be more than 10. Clearly, advancement to E-5 affects retention more strongly than what would be expected from the pay increase alone.[1] This suggests that advancement in itself may be an effective retention tool, a point that will be considered later.

TABLE 9

MONTHLY RMC AT LOS4, FY 1978

Pay grade	RMC[a]	Pay index (E4 = 1.00)
E-3	$ 815	.92
E-4	889	1.00
E-5	930	1.05
E-6	1021	1.15

a. The calculation of RMC depends on the number of dependents. These values assume the individual is married and has one child.

The comparable pay elasticity for advancement from pay grade E-5 to pay grade E-6 is just over 2, suggesting that there is little additional effect beyond that of pay for this advancement. So few individuals have achieved pay grade E-6 during the first term, however, that this result should be treated cautiously.

Retention and Quality

To this point, the analysis of retention has not differed dramatically from that conducted by many others. A direct measure of productivity in the study's estimates of retention has been included, but it has no significant impact on retention. The only result that differs from those of earlier analysts is the treatment of advancement as an explanatory variable. The obvious question to ask about retention is, how do the economic variables, such as pay and SRB levels, affect the quality of the career force?

The work presented so far assumes that the effect of pay, as measured by the pay elasticity, is identical for all individuals. This

1. Some caution is required in the interpretation of these findings. Individuals who intend to reenlist may be more likely to make an effort to reach PG5 by end of active obligated service (EAOS). As a result of this reverse causality, the coefficient on PG5 probably overstates the policy impact of an increase in the advancement rate on retention.

type of model predicts that as pay increases, the Navy will retain more personnel but the quality distribution of personnel will remain essentially constant. If, on the other hand, the responsiveness to pay is different for individuals with differing characteristics, then changes in pay or in the national economy may have a significant impact on the quality of the career force retained.

Researchers stratified the data set by measures of quality, then estimated separate reenlistment equations. The study involved too few non-HSDGs to stratify on that variable; therefore, the data was stratified by mental group (MG). Summary calculations of the implied reenlistment elasticities are displayed in table 10.

TABLE 10

REENLISTMENT ELASTICITIES

	(1) All	(2) MG I-IIIL	(3) MG I-IIIU	(4) MG I-II	(5) MG III
Pay (calculated from SRB)	2.2	2.8	3.1	4.1	1.1
Unemployment	1.8	2.0	2.7	2.7	1.4

These results indicate substantial differences in the impact of pay and unemployment across mental groups. In general, changes in Navy pay have the largest impact for the top groups. Conversely, if pay declines, the Navy will experience the greatest losses in those groups it most values.

Examining the pay elasticities derived from the SRB variable shows that the estimates depend significantly on which group of personnel is being studied. For the full sample of individuals making a reenlistment decision, the elasticity is 2.2, which is comparable to that found in numerous other studies. This overall result, however, masks some important differences. Individuals in MGIII (column 5) have an elasticity of 1.1, which is substantially lower than the average. At the other end of the distribution, personnel in the top two mental groups (column 4) are much more sensitive to pay. These results imply that a 5-percent pay increase will lead to a 20-percent increase in expected reenlistment rates for personnel in the top mental groups but only a 5-percent increase in reenlistment rates for the rest of the first-term personnel.

The estimates of responsiveness to the unemployment rate are consistent with estimates of responsiveness to pay. The differences across groups are not quite as large as those concerning responsiveness to pay;

still, they imply that as the unemployment rate declines from its extremely high levels of the early 1980s, the people who are the most valuable to the Navy will be more likely to return to the civilian sector at the end of their first term.

Table 11 shows the results of simulated changes in SRB levels on the quality mix after the first reenlistment point. When the average SRB level changes, the distribution changes substantially. Comparing a one-level increase to a one-level decrease reveals a 10-percentage-point difference in the proportion of careerists in the top two mental groups.

TABLE 11

SIMULATED EFFECTS OF PAY ON QUALITY

SRB change	Second-term MG distribution (percent)				Overall increase (percent)
	MGI-II	MGIII-V	MGI-IIIU	MGIIIL-V	
0	38.8	61.2	57.8	42.2	--
+1	42.6	57.4	60.8	39.2	13
-1	33.9	66.1	54.0	46.0	-13

Conclusions

The results of the foregoing analyses reconfirm the standard rule of thumb that the appropriate pay elasticity for predicting aggregate first-term reenlistment is about 2. This standard result disguises some important differences within the first-term force, however. The most able personnel (defined in this case by mental group) are the ones most sensitive to changes in economic conditions. General pay or SRB increases not only induce more retention, but do so disproportionately for the best-qualified people. Conversely, if Navy pay lags behind the civilian sector, the resulting manpower shortages will be concentrated among the most able personnel.

Another finding of note concerns the importance of advancement to the reenlistment decision. The impact of advancement to E-5 on retention is very large. The associated pay increase is relatively small, which suggests that advancement in itself is an efficient retention tool. Advancement is also a well-targeted policy: the Navy advances those individuals who are the most valuable. Clearly, it is unreasonable to advance everyone in a rating, but the results suggest that a policy of faster advancement in undermanned ratings can have a substantial impact on retention--one that is directed at the best-qualified people.

SEA PAY

Maintaining adequate retention levels is important to all four branches of the military in meeting their overall personnel objectives. This is accomplished, in large part, through general DoD-wide pay increases and reenlistment bonuses directed at specific ratings or specialties. Navy personnel are unique, however, in that they must accept sea duty involving long family separations. As a result, compensation for this type of work--sea pay--has existed throughout most of the history of the U.S. Navy. It is a significant part of total compensation. In recent years, the Navy's sea-pay budget has been approximately equivalent to that for the SRB program. Sea pay is likely to have a signficant impact on retention in general and on the ability of the Navy to fill billets at sea in particular.

The analysis of sea pay for this project centered on developing information on the distribution of time at sea and the distribution of sea pay. In other words, who spends time at sea and how much sea pay do they receive? Answers to these questions are necessary before policy issues such as the impact of sea pay on retention and voluntary extensions at sea can be addressed. The data required to answer these questions were not readily available anywhere in the Navy and had to be developed as part of this project.

Description

From 1949 to 1978, sea pay was calculated at a fixed rate that varied with an individual's pay grade. The amounts remained unchanged for 30 years with the result that the value of sea pay in real dollars dropped to slightly over one-third of its original value. Since 1978, four sea pay tables have been used. The table that was in effect from October 1978 through August 1979 is similar to the one used from August 1979 until the end of 1980. These two tables applied only to petty officers and varied only according to years of sea duty. The three sea-pay tables are shown in tables 12 and 13.

Tables 14 and 15 show the current sea-pay table and its immediate predecessor. These tables combine the attributes of the earlier sea-pay schemes by making sea pay depend on both pay grade and cumulative time-at-sea. The most recent changes have allowed for additional increases in monthly sea pay for senior personnel with more than 10 years of sea duty. These changes were designed to increase the incentives for senior personnel to go to sea. This portion of sea pay is known as Career Sea Pay (CSP). An additional feature of the program is the CSP premium. This pay is $100 per month for anyone who is eligible for CSP and who has been on continuous sea duty for 3 consecutive years. It is designed to compensate for long periods of sea duty and to encourage voluntary extensions at sea.

TABLE 12

SEA PAY, JANUARY 1949-SEPTEMBER 1978

Pay grade	Monthly rate (dollars)
E-1	8
E-2	8
E-3	9
E-4	13
E-5	16
E-6	20
E-7	22
E-8	22
E-9	22

TABLE 13

SEA PAY, OCTOBER 1978-DECEMBER 1980

(E-4--E-9)

Sea duty (years)	Monthly rate (dollars)	
	Pay table 1[a]	Pay table 2[b]
3+	25	24
5+	35	40
7+	35	52
9+	35	63
10+	35	75
11+	35	86
12+	55	115

a. Effective 1 October 1978 to 31 August 1979.
b. Effective 1 September 1979 to 31 December 1980.

TABLE 14

SEA PAY, JANUARY 1981–SEPTEMBER 1984

Pay grade	Monthly pay according to years of sea duty: 1 or less	Over 1	Over 2	Over 3	Over 4	Over 5	Over 6	Over 7	Over 8	Over 9	Over 10	Over 11	Over 12
E-4	$ 50	$ 60	$125	$160	$175	$175	$175	$175	$175	$175	$175	$175	$175
E-5	60	70	140	175	185	190	205	220	220	220	220	220	220
E-6	125	135	170	190	210	215	225	235	245	255	255	255	255
E-7	135	145	215	235	255	260	265	265	270	275	280	300	310
E-8	165	180	225	255	265	270	280	285	290	300	310	310	310
E-9	175	195	235	265	280	290	310	310	310	310	310	310	310

TABLE 15

SEA PAY, OCTOBER 1984–PRESENT

Pay grade	Monthly pay according to years of sea duty[a]: Over 10	Over 11	Over 12	Over 13	Over 14	Over 16	Over 18
E-4	$175	$175	$175	$175	$175	$175	$175
E-5	220	220	220	220	220	220	220
E-6	265	265	280	295	310	325	340
E-7	280	300	310	330	350	370	390
E-8	310	310	320	340	360	380	400
E-9	320	330	350	370	390	410	410

a. Pay rates for members with less than 10 years of sea duty are the same as in Table 14.

Findings

The study team obtained information on cumulative time-at-sea and sea pay for enlisted personnel from the Navy Finance Center, Cleveland. The team was unable to obtain data on continuous time-at-sea in machine-readable form. As a proxy measure, the team collected data on the number of individuals receiving CSP premiums. Table 16 shows descriptive statistics on individuals receiving sea pay. One interesting fact that becomes apparent is that a relatively small proportion of petty officers actually receive sea pay. In the 3 years analyzed, less than a third received sea pay at any one time. Another interesting finding is that the number of personnel receiving CSP premiums increased over the same period. This is in accord with the notion that the premium has led to voluntary extensions at sea, but the time period is too short to confirm this result.

TABLE 16

PERSONNEL COUNTS FROM SEATIME DATA

Year	Net total E-4 to E-9	Persons receiving CSP	Percent receiving CSP	Persons receiving CSP premiums	Percent receiving CSP premiums
1982	307.5	107.1	29.1	9.8	2.7
1983	397.5	117.2	30.2	16.6	4.3
1984	426.9	117.2	27.5	19.5	4.6

These results give some indication of the average Navy-wide time-at-sea and sea pay. To get a finer breakdown, the study derived separate statistics for two rating groups; these are shown in table 17.

TABLE 17

RATING GROUPS

Sea Intensive/Mission Critical	BT, EM, EW, FTS, FTM, GM, GMG, GMM, GMT, GS, GSE, GSM, HT, IC, MM, MR, OS, ST, STG, STS
Shore Intensive	AB, AC, AD, AG, AK, AS, ASG, ASM, AT, AV, AZ, CE, CTA, CTI, CTM, CTO, CTR, CTT, CU, DK, DM, DP, DT, EA, EO, EQ, HM, IS, JO, LN, MN, MU, NC, OT, PC, PH, PI, PN, PR, RP, UT, YN

Figure 6 displays the average number of years at sea by pay grade for the Mission Critical and Shore Intensive ratings along with the Navy average. Large and widening differences exist between the rating groups in the number of years they spend at sea during their careers. The degree to which this is reflected in the sea-pay tables is indicated in figure 7. This figure shows the monthly Career Sea Pay that a petty officer earns at sea, differentiated by pay grade and rating group. It illustrates the fact that the sea-pay table depends on pay grade to a greater extent than on cumulative sea time.

These results do not indicate whether or not the sea-pay program is an effective tool for compensating personnel for arduous duty or for increasing retention in sea-intensive ratings. The goal of this research effort was to develop sufficient data to answer some very simple questions about the distribution of time-at-sea and sea pay across the range of Navy personnel. The results presented provide a general overview of these distributions. Further analysis is required to fully understand the effect of the sea-pay program on retention and on the Navy's ability to fill its billets at sea. The work done in this study to develop data is a necessary first step in this direction.

SUMMARY

The Navy is in a decade-long process of building a 600-ship force. This growth requires a comparable increase in the number of personnel to man Navy ships and aircraft squadrons and to man the shore establishment to support them. The Navy has been successful in the first half of the 1980s in meeting its personnel objectives, but the second half of the decade presents new challenges. A declining population of young people, an improving economy, and budgetary pressures combine to make the task of manning a growing fleet more difficult. As a result, the Navy needs to accurately determine its manpower requirements and employ cost-effective personnel policies to fill them. This report summarizes research conducted to help improve the Navy's ability to accomplish these goals.

The research covers three areas: manpower requirements, the effect of manning policy on fleet readiness, and the impact of compensation and personnel policies on the retention of career personnel.

Models were developed to project personnel requirements for different force mixes, to explore the possibilities for civilian substitution, and to determine recruit quality requirements. These models can serve as the basis for workable management tools.

The number and types of personnel in the Navy are important influences on Navy readiness. The relative contributions of different types of personnel to measures of individual performance were analyzed--in particular, the growth of productivity during the first term and its potential decline after leaving the active Navy. The results showed that recruits do not contribute greatly to unit output until after a

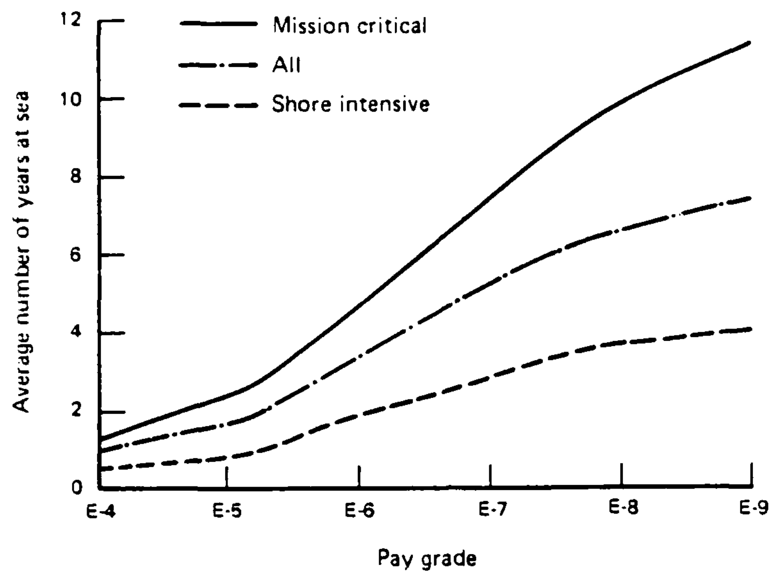

FIG. 6: AVERAGE SEA TIME BY GROUP AND GRADE (DEC 1983)

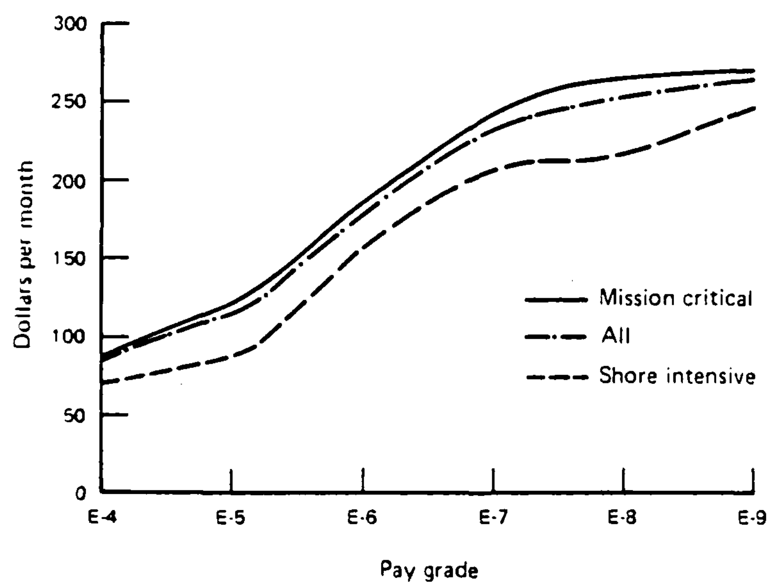

FIG. 7: MONTHLY CAREER SEA PAY BY GROUP AND PAY GRADE (DEC 1983)

substantial portion of the first term. On the other hand, under the present training policy, Selected Reservists maintain their acquired operational skill even after periods away from active duty.

The study analyzed the sensitivity of reenlistment decisions to pay of personnel from varying quality groups. Results suggest that the most able personnel are the most sensitive to changes in economic conditions in the Navy and in the private economy. Finally, data on the Career Sea Pay program were developed and analyzed. The distribution of sea duty and the corresponding distribution of sea pay showed that less than a third of petty officers receive sea pay at any given time, that CSP seems to have increased voluntary extensions at sea, and that the sea-pay table depends more on pay grade than on cumulative time-at-sea.

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